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## Reporting Progress

In the area where the iron foundry industry is being concentrated, negotiations are still in progress, and a number of changes from the original plan have been sanctioned. It has been obvious from the beginning that a purely geographical basis is quite often unsatisfactory. For instance, the telescoping of a pianoforte frame factory with a railway shop and a general jobbing foundry, though purely hypothetical, is representative of what may be and has been asked for. Another rumour, to which some credence can be given, is that an ironfoundry employing less than ten men—presumably "on the clock"—can contract out of the scheme, but thereby they forfeit the right to supplies of raw materials. If by any chance they may be tempted to do so and rely on the black market, they would be very ill-advised, as recently there has been a round-up and very severe penalties imposed. Actually, the Board of Trade is quite receptive to suggestions of alternative proposals, providing the basic principles are adhered to. The uniting of purely jobbing shops is the feature which has given the most headaches, because of trade rivalries and future prospects. A suggestion has been made that the nucleus foundry in any one particular locality should, in common with the closed-up concerns, trade under a new name, such as "Sheffchester" No. 2 or "Manfield" No. 1 District Foundry. It is felt that such a system would prevent the nuclear foundry from obtaining the advantage of perpetuating its name, whilst its competitors were closed down. Another anomaly which is being discussed is that of the maintenance of the closed-down foundry. It seems, on the one hand, to be the duty of the nuclear concern, whilst on the other the onus has every appearance of being placed upon the owners of the closed-down concern! Because of the great diversity of the foundry industry it can happen, and indeed it has occurred, that an ironfoundry may be an integral part of a concern scheduled as a nucleus establishment of a quite different concentrated industry, yet it may be told to shut down under the ironfoundry scheme.

It will be remembered that very short notice was given to the first area affected, but the original date, May 15, has been extended so that adequate arrangements can be made. Negotiations are still in progress, and whilst the basic conditions are being enforced, quite a few of the modifications proposed by the district employers' association have every prospect of being accepted. For instance, at the suggestion of the trade, an extra nucleus foundry may have been added or the transference to a nucleus position of one which was scheduled to be shut down. Officials have already visited the various concerns in order to familiarise themselves with local conditions. We have detailed all this, in order to acquaint districts which may be affected in the future of the actual operation of the scheme in its initial stages.

It should not be taken for granted, in fact it would be misleading to do so, that because an ironfoundry is engaged upon important service contracts, that it will be unaffected when the new order becomes applied to the area in which it is located. It will become either "nuclear" or "closed down." Thus, no matter where an ironfoundry be situated, it is good policy to prepare the way for this eventuality by contacting, through the appropriate employers' association, with neighbouring concerns, because, as we have pointed out, the Board of Trade is quite ready to listen to and, where good reason can be shown, endorse alternative schemes which are more easily workable. The experience gained from the operation of the first area to be concentrated will be of great use to the other districts. The valuable information now in the hands of the employers' associations should go far to smooth out fairly rapidly the difficulties of the next area to be involved.

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# CORRESPONDENCE

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

**Dormant Branches**

SIR,—As a Past-President of the Newcastle Branch of the Institute of British Foundrymen, I cannot but feel resentment at your reference to this Branch in your leader of the May 14, 1942, issue. In the first place it proves that this was written without consideration of recent events of the Branch. Furthermore, the terms of reference are such as not to encourage increased activity.

It is well known in any society that the initiative generally comes from a few members. In the case of Newcastle these few are very actively engaged in other directions.

Had you taken note of Mr. Bolton's report on his visit to Newcastle, when a representative meeting of the Branch Council took place, you would have seen that a technical meeting had been arranged for the late summer, to commence the winter activities of this Branch. You would also have seen the unfairness of singling it out as the No. 1 "dormant" Branch.

I should also like to assure you and your readers that if Newcastle Branch has not held the usual regular meetings, this area is still forging ahead technically, and when more time is available it will be able to contribute its usual quota on both metallurgical and foundry technique.

Of the two Sections of the Institute, *i.e.*, Technical and Social, it is the latter which has suffered the more. This is no crime in wartime.—Yours, etc.,

W. SCOTT.

Sir W. G. Armstrong Whitworth & Company (Iron-founders), Limited,
Close Works, Gateshead-upon-Tyne.

May 19, 1942.

[We are pleased to learn that after an interval of more than two and a half years the Newcastle Branch is resuming activities, and are sorry that our leader was published after this reawakening. Now that Mr. Scott is personally interesting himself in the affairs of the Branch, its future activity and success are assured. He can rely on all help possible from us. Letters from the Branch-President, Mr. E. B. Ellis, and the honorary secretary (Mr. C. Lashby) have been received and cover much the same ground.—Editor.]

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**The new American G.E.C. steel foundry laboratory** in Schenectady is housed in a fluorescent-lighted brick structure adjacent to the foundry, and is equipped so that the latter can be furnished with a preliminary quantitative analysis of any steel sample within half an hour after it has been removed from a furnace. Weighing is done by balances located in the centre of the laboratory and mounted on a slate-covered, vibration-proof concrete pier. The latter has its footing 4 ft. below the ground surface, has no point of contact with the building, and is surrounded by cork board that serves as a shock absorber.

# JOBBING FOUNDRY EXPERIENCES

## XXXVI—By "Tramp"

There are a number of jobs in which the top and middle portions of the mould have to be well "stayed" to carry the weight of the sand, etc., and avoid a drop-out. To be effective, staying has to be conscientiously done, for, if skimped at all, trouble will doubtlessly arise. Much time is often occupied in this operation, and speed of production can be increased if thought be applied to this part of the work. Fig. 1 illustrates a portion of a drum for a colliery winding engine, diameter D being about 5 ft. and depth of flange A from 9 to 12 in., while the distance between the flanges is from 1 ft. 6 in. to 3 ft., depending on the rope capacity required. The method of staying the

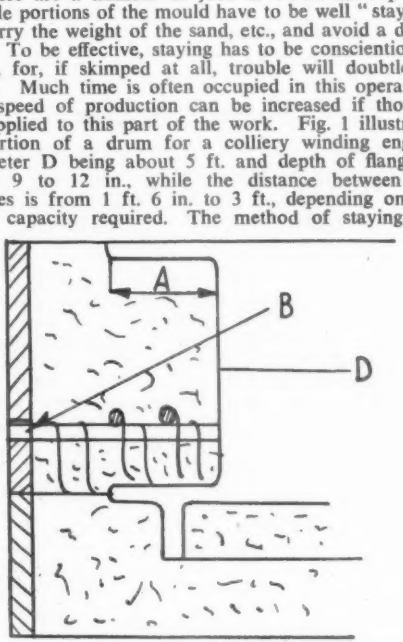


FIG. 1.—PART OF DRUM FOR COLLIERY WINDER.

middle portion of the mould is to place a 2-in. bar through holes in the moulding box as B at each end, and on to these two other bars are placed at right angles and just touching the box at each end. Stays are then suspended from these bars and the middle rammed up. On a particular job being made by this method, the holes B were over 1 ft. up from the joint, thus needing long stays and two rammings before they were covered, so that a pneumatic rammer could be used. By reducing the height of the position of the holes, shorter stays could be used which could be covered at one ramming, and then the remainder of the middle could be completed much quicker. If the job was required in quantities, it would be better to eliminate stays and use joint grids, but for occasional castings stays are satisfactory.

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**American production** of commercial steel castings last year totalled 1,316,027 tons, the largest since 1929 and almost doubled the 1940 figure, according to returns of the U.S. Department of Commerce.

# SAND CASTING OF SILICON BRONZES AND P.M.G. METAL*

## *Part A.—Some Causes of Defects in Brass and Bronze Castings: Moulding Faults, Moisture, Scabbing, Running Conditions and Vents*

By W. MACHIN, O.B.E.

The manufacture of castings in the numerous brasses and bronzes for shipbuilding and engineering requirements to-day is an industry built upon the solid and dependable foundation of experience. A formidable task it would be to outline even those difficulties personally encountered over many years, more overwhelming to attempt to detail more than a fraction of the valuable information garnered by combined study, experiment, sometimes failure, and ultimate success. Where a standard type of casting is concerned, it may be said that successful production is, to a great extent, due to an established method built up by individual experience, or to one of generally accepted practice, but the constantly changing nature of modern requirements repeatedly introduces new problems for solution.

Each phase in the making of a mould must be carefully considered in the light of results already obtained, and it may be assumed that the greater proportion of defectives are caused by the workman overlooking some small but important detail of procedure.

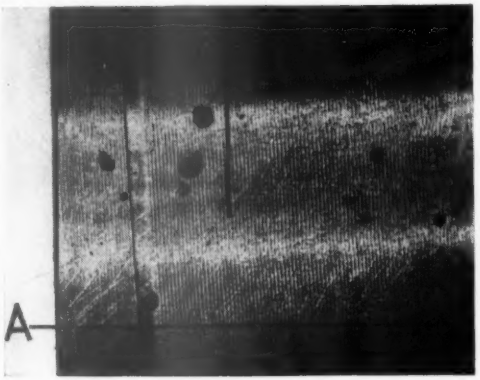


FIG. 1.—DEFECTIVE PORTION OF GUNMETAL LINER.

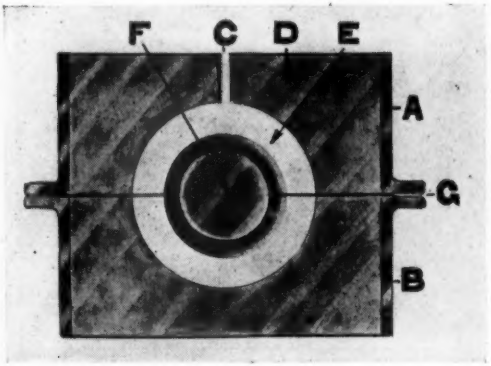


FIG. 2.—METHOD OF MOULDING THE SAME LINER.

The composition, temperature and treatment of the metal are to be taken into account, factors which, accepted in their true perspective, are of the greatest importance in the production of a sound casting. The technique of metal melting has been comprehensively dealt with frequently, and it is, therefore, not necessary to refer at length to that aspect in connection with this Paper; it is intended to deal with the practical side, in outlining some of the causes of defects in brass and bronze castings. Prominent among hundreds of non-ferrous metals at present in use are gunmetal, and what is known in the foundry as manganese bronze, and it is intended to deal with rejects and replacements in these alloys as well as others, all of which are related in so far as the moulding and other operations in the foundry are concerned.

### Defects due to Moulding Faults

Foundrymen cannot guarantee to produce 100 per cent. good castings, so the question of some castings rejected as a result of defects brought about by faults in the moulding technique will be

* A Paper read before the Lancashire Branch of the Institute of the British Foundrymen, Mr. E. J. L. Howard presiding.

covered. It is appreciated that ideas may differ substantially on many of the points raised, and in putting forward this Paper it will be understood that actual experience is represented involving altered method and the results obtained. In many instances, even after alterations have been made to moulds, and success attained, further similar castings have been rejected, the reason in almost every case being that a small but important detail in the moulding technique has been overlooked.

More castings are defective, and a correspondingly greater proportion rejected, through faults in the mould, and cores, than are given attention from the angle of troubles associated with melting. Whilst melting is of paramount importance in castings production, the purpose of this Paper is to stress particularly a few of the points in technique which the moulder does sometimes regard as unimportant.

### Effect of Moist Material

The mould for the casting shown in Fig. 1 was cast horizontally. The mould joint was as indi-

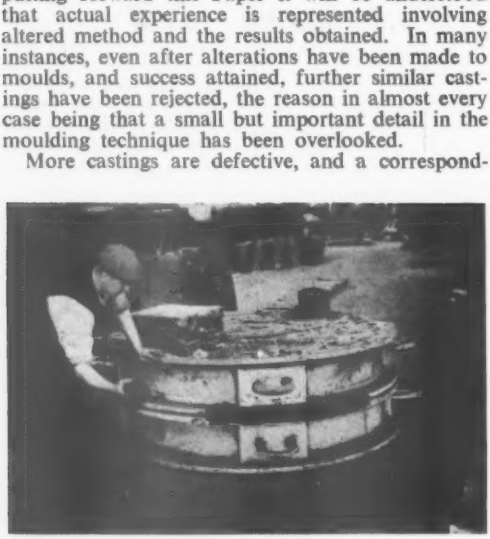

FIG. 3.—STOPPING UP THE JOINTS OF A DRY SAND MOULD.

FIG. 4.—SHOWING END OF CORE RAMMED WITH SAND.

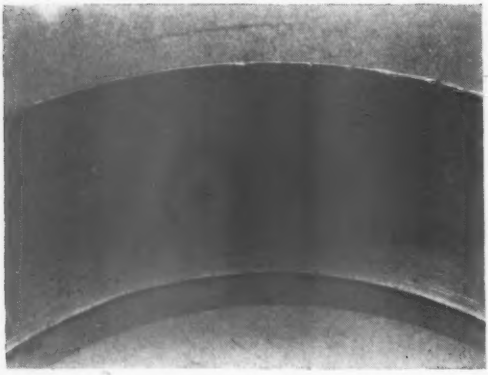

FIG. 5.—PORTION OF CASTING SHOWING BLOWHOLES ON MACHINED FACE.

FIG. 6.—PATTERN IN POSITION READY FOR MACHINE MOULDING.

## Sand Casting of Silicon Bronzes

cated at A, and the defect was caused through moisture from damp material, *i.e.*, moisture from loam used for stopping in the joint between the two halves of the moulding box having been drawn into the mould. The mould was made by a competent workman; a perfectly vented core was placed in position and the mould closed, everything being apparently in perfect condition for the production of a sound casting. The casting was produced, and, during machining, defects were discovered as shown in Fig. 1.

Before the next mould was put in hand close examination was given to the method employed in the manufacture of the defective liner, and the sources of the trouble were revealed. A and B

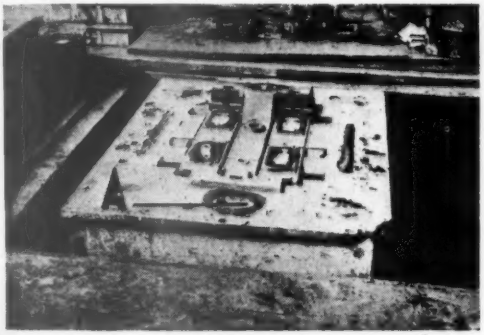


FIG. 7.—THE DOWN RUNNER.

of Fig. 2 show the upper and lower halves of the mould, C the riser, D the sand, E the casting cavity, F the core, and G the joint between the two halves of the mould. The gap G between the two parts of the moulding box had been stopped up with damp material in the form of loam, with the object of preventing the escape of molten metal. At C in this instance, as in numerous others, the riser in the upper half of the mould acts as a chimney, and the steam generated by the warm mould from the moist loam is drawn through the joint from gap G.

Reverting to Fig. 1, it will be noted that the blowholes are actually in line with the riser, as indicated by the direction of arrow B, thus establishing that the defect has been due to the presence of steam in the mould at this part. This unsatisfactory method has been the cause of this defect in numerous instances, there being no real need to stop up joints in this manner. Providing the two halves of the mould are securely fastened together to prevent lift during the casting operation, the metal will not leave the mould if the joint is not disturbed during the casting operation.

In Fig. 3 loam heavily loaded with moisture is shown being thrown into cavity G, Fig. 2, between the top and lower half of the mould. The moulder's intention, obviously for safety purposes, is to prevent risk of the metal escaping through the joint. It is undoubtedly certain that a large percentage of bad castings is the outcome of this unnecessary procedure. Very similar trouble can be experienced in dry-sand moulds where moist stamping material may not have been thoroughly dried around the end of the cores.

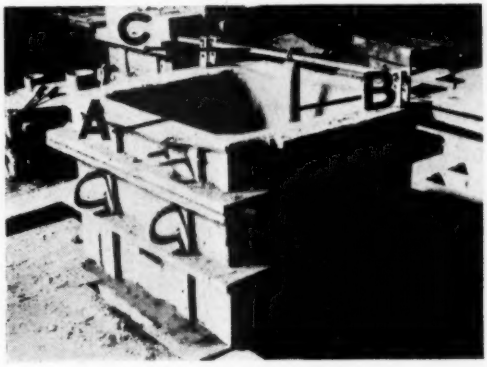


FIG. 8.—THE RUNNER BASIN.

In Fig. 4, F shows the end of the core, D the cavity between the core and moulding box, and E the casting cavity. The sand rammed in cavity D holds moisture which can be drawn through joint H by the assistance of suction from riser C acting as a chimney. A better method would be to use a thin loam stamp at position G, making certain that the same be properly dried before the top half of the mould A is placed in position. Under these conditions the two halves of the moulding box A and B must be securely fastened together to prevent strain during the casting operation, otherwise leakage of metal may occur through the joint of the mould G illustrated in Fig. 2.

In a busy foundry making many different types and classes of castings foundrymen are aware of the varying temperatures at which different moulds

are cast. If portions of the mould or cores have been lying about for a few days after being dried, and, therefore, are cold when closed, care should be taken that moisture has not been picked up, otherwise such condition may cause the defect known as porosity (Fig. 5).

It will be noted that the small holes are general—

FIG. 9.—THE RUNNER BASIN READY FOR THE CAST.

FIG. 10.—THE CASTING OPERATION.

quite different from those shown in Fig. 1, which are local. In many cases under observation, incorrect melting has been blamed for this defect, but it has been proved that it has been due to the presence of moisture.

### Scabbing

Another type of defect which has given serious trouble is that known as scabbing, which brings about the appearance of sand on faces to be machined which are cast uppermost in the mould. This is due to sand becoming loose from the face of the mould, or core, and floating on the top of the metal during the casting operation. The sand becomes trapped in some projection, ledge, etc., in the mould or cores, and remains there. This type of defect can usually be found before the casting leaves the dressing shop, as the scab is easy to see if the casting is examined after being cleaned, and before any dressing or chipping is carried out. Scabs can also be caused by faults other than the presence of moisture, *i.e.*, unsuitable sand for the particular mould or cores, or insufficient venting.

In general, however, defects from scabbing are not nearly so frequent as those due to the presence of moisture. Those instanced cause the same defects to appear in other non-ferrous castings made from manganese bronze, phosphor bronze, yellow brasses, nickel bronzes, and silicon alloys. In addition there are also defects which can be definitely traced to the slow running of the mould, and, perhaps, also to feeders which have been put in unsuitable positions.

## *Sand Casting of Silicon Bronzes*

### Fast Running Essential

In all these classes of castings fast running is considered essential for the realisation of good results. It has been observed that many defects found in manganese bronze castings are the results of slow running, evidenced by subsequent leakage on pressure test and/or spongy patches in the areas

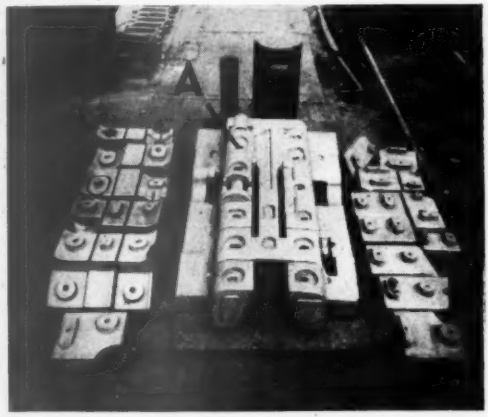

FIG. 11.—THE LARGE NUMBER OF CORES USED IN THE JOB.

most remote from the inlet to the mould, or from the main runners connected to the basin. The correct method, in the author's opinion, for casting manganese bronze is as illustrated in Fig. 6, *et seq*.

In Fig. 6 the inlets to the mould are marked A and B, and through these inlets passes all the metal required to fill the mould on its under part "as-cast." It will be noted that the runners are placed in such positions that the two separate streams of metal are travelling in the same direction.

The down runner on the joint of the mould is shown at A (Fig. 7); thus, this connected to a cross runner in the bottom of the mould feeds the two streams shown at A and B in Fig. 6. The one down runner is continued in a straight line through the top half of the mould, and is coupled up to the runner basin.

The runner basin A (Fig. 8) is large enough to take the whole of the metal required to fill the mould, and plug B prevents any metal entering the mould during the operation of filling the basin. It will be noted that the plug B is securely fastened by means of a bar C through the top of plug B. This is to prevent the plug lifting whilst the metal is being poured into the basin.

Fig. 9 shows the basin at A full of metal, and the two moulders are seen ready to lift the plug and allow the metal to run into the mould. It will be appreciated that immediately the plug is removed the whole of the metal will be transferred into the mould at a high speed.

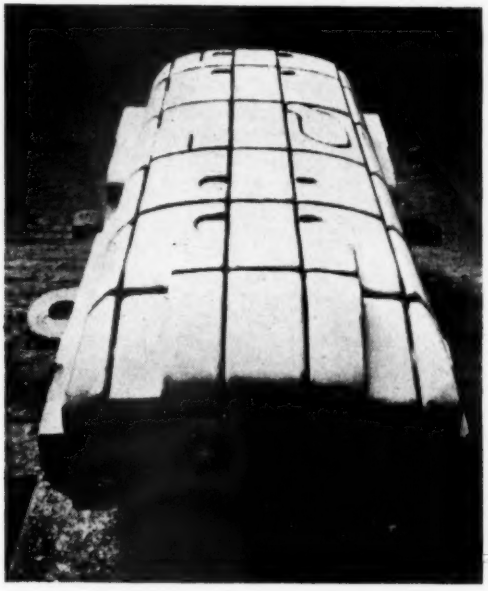

FIG. 12.—THE COMPLETE ASSEMBLED CORE.

In Fig. 10 the plug A can be seen lifted from the inlet to the mould, thus releasing the metal from the basin. It will be observed that no ladle is in attendance during this cast, the operation being carried out smoothly and without any flurry, which is desirable to ensure that every detail of the casting technique is correct. Under these conditions the running method is under more perfect control than would be the case with a ladle and a small basin. With the latter condition the speed of casting is controlled by the human element, *i.e.*, by the man who is operating the ladle, and in many observed cases the basin has not been

## *Sand Casting of Silicon Bronzes*

kept full, with the result that the speed of casting has been too slow. In the former case, the method is foolproof as the runners are always full.

### Importance of Clear Vents

It is sometimes stated that this high speed of

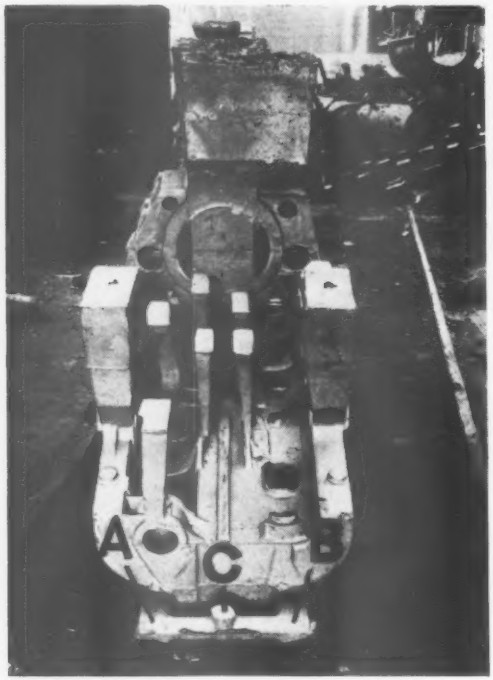


FIG. 13.—THE CASTING.

casting is risky owing to the possibility that the large number of cores, sometimes used in the make-up of the completed mould, may be moved out of position by the additional pressure, due to fast running. Thus, clear vents from all these cores are essential, it being very important to control this factor, otherwise poor results are certain. In Fig. 11 the vents in the cores are clearly illustrated, one of which is marked A, and these vents should be carefully connected from one to another during the time the cores are being assembled, to form the completed core (Fig. 12). This core can be seen placed in position in Fig. 7, and care should be taken to see that the vents are correctly sealed when being connected together, so that no metal leakage occurs into them.

The feeders and runner inlets are shown in Fig. 13 at A and B. The down runner connecting to the runner inlets and to the basin can be seen

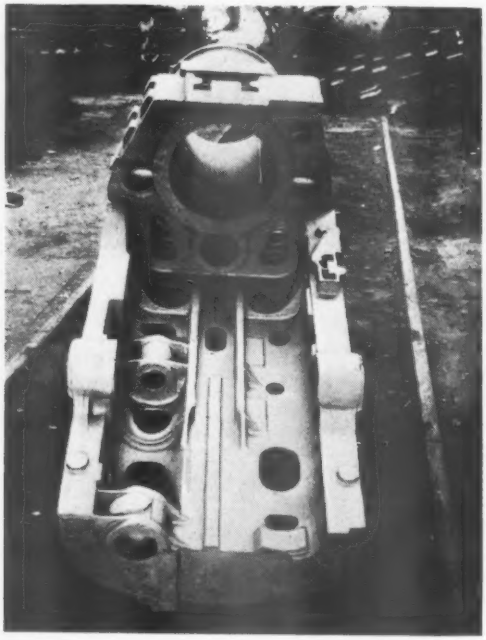

FIG. 14.—THE FINISHED CASTING READY FOR MACHINING.

at C. It will be noted that all the feeders and runners have been cut away.

(*To be continued.*)

**Impact Test for Vitreous Enamelled Utensils.**—At the recent annual convention of the American Ceramic Society, held in Cincinnati, G. H. Zink and A. I. Andrews, of the Department of Ceramic Engineering University of Illinois, Urbana, gave a description of the equipment and method of testing all sizes and shapes of vitreous enamelled kitchen utensils. Factors which influence the development of the equipment and the test procedure were discussed in detail.

# CUPOLA-MELTED HIGH-DUTY CAST IRONS

## *Practical Experience of a New Departure in Cupola Practice in Making High-Strength Irons*

By W. W. BRAIDWOOD

(*Continued from page* 94.)

### The Nuclear Theory

The nuclear theory is given further support by Massari and Lindsay.[9] By experiments on low-silicon irons, these collaborators have demonstrated that ladle additions of graphite exercise a very potent graphitising influence, and can produce startling alterations in the structure of chill cast test-pieces. No attempt can here be made to summarise the vast amount of accurate work described in this Paper, which should be read in its entirety by all interested. It is sufficient to state that all of the results are explainable on the basis of the existence of graphite nuclei and strongly support the theory that one of the basic factors influencing the graphitising behaviour of an iron is the number of graphite nuclei present at the moment of solidification.

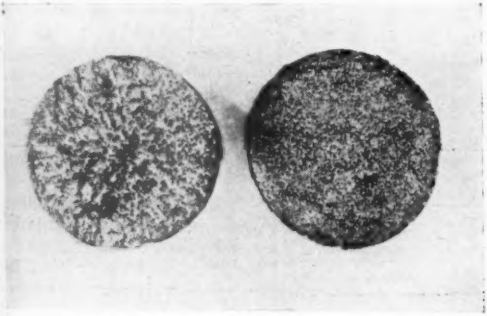

FIG. 11.—1.2-IN. DIA. TEST-BARS.

It is now realised that low-carbon irons tend to exhibit dendritic structures with the graphite present as fine, inter-dendritic deposits. It has been found that this arrangement, while exercising no appreciable influence on tensile strength, greatly reduces the resistance to shock. Much has been learnt as to the formation of graphite, and foundrymen have been informed of the means by which the production of random graphite may be assured. The writer's own experiences in the employment of inoculation technique may now be described.

### Inoculation Technique

Supplies of graphite in the form of discarded electrode, in the lump, granulated and crushed conditions, were available, and use was first made of the powdered material. Test-bars poured before and after the addition proved this to be completely successful in producing random graphite and improved resistance to impact. In order to obtain unmistakeable proof of the potency of such additions, it was arranged to tap a low-silicon iron calculated to yield a mottled structure in the 1.2 in. dia. bar. Clear evidence of the inoculating effect, capable of interpretation by any foundryman, would then be provided by photographic reproduction of the fractures of the bars poured before and after inoculation. These are featured in Fig. 11, which shows the respective fractures, left and right, of the bars poured from melt No. 139.

FIG. 12.—TEST-BAR FROM MELT NO. 139*a*. PHYSICAL PROPERTIES: HARDNESS, 299 BRINELL; TENSILE STRENGTH AND IMPACT, UNMACHINABLE. ETCHED (3 PER CENT. NITAL) × 250 DIA.

For the benefit of the metallurgically trained,

## Cupola-Melted High-Duty Irons

Figs. 12 and 13, which show the etched structures of the respective bars, each at a magnification of 250 diameters, have been prepared. It will be noted that the graphite present in the mottled bar is in the form of small interlacing deposits obviously formed from the carbide, which is a prominent constituent of the microstructure. The inoculated bar, however, contains graphite of the normal flake type only, and no free carbide is present. Such striking alteration in structure, explainable only if complete change in the process of graphite formation be visualised, cannot, in this instance, be attributed to change in composition, since the increase in carbon content accompanying inoculation was only 0.7 per cent.

Subsequent experiments proved granular and lump electrode to be successful inoculants also, and full details of the melts concerned are quoted in Table VI. The results show that inoculation by ladle addition of graphite is a perfectly practicable proposition. Attention is particularly drawn to the case of melt No. 143, in which lump electrode was employed, and where, though the carbon increase was only 0.03 per cent., a definite alteration in graphite form was produced and a substantial increase in impact resistance obtained.

For ladle addition, electrode graphite is probably most suitable in lump form. The inoculating effect is potent, increase in the carbon content of the metal is slight, recovery of unconsumed electrode is easy and efficient, and pouring suffers no inconvenience from the presence of electrode stubs on the metal surface.

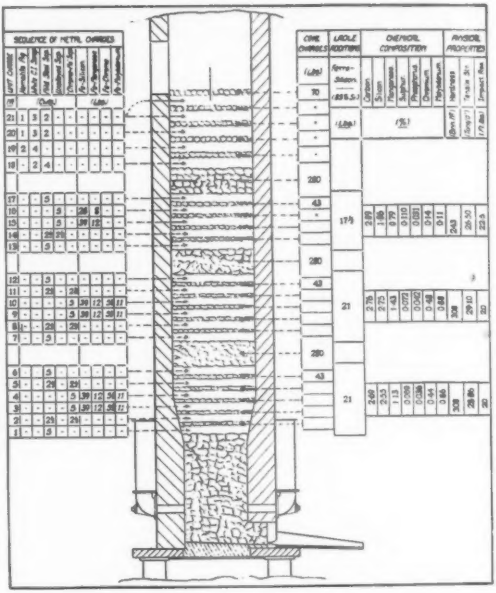


FIG. 14.

TABLE 6 — THE INFLUENCE OF LADLE ADDITIONS OF GRAPHITE

| MELT No. | NATURE OF THE LADLE ADDITION | HISTORY OF THE MELT | CHEMICAL COMPOSITION. TC % | CC % | Si % | Mn % | S % | P % | PHYSICAL PROPERTIES. Hardness (Brin. No.) | Tensile (tons/sq.in.) | Impact (ft. lbs.) | MICROSTRUCTURE. GRAPHITE | MATRIX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 139a | ——— | As tapped; poured just prior to inoculation | 2·58 | 1·41 | 1·55 | 1·09 | 0·079 | 0·038 | 299 | Unmachinable | | Mottled fracture. Some lacy reticular graphite in centre | Pearlite Cementite |
| 139b | Ground Electrode. (Thro' - 14·44 mesh) | Poured two minutes after inoculation | 2·65 | 0·60 | 1·53 | 1·08 | - | - | 210 | 20·80 | 18 | Long random flakes only | Pearlitic |
| 138a | ——— | As tapped; poured just prior to inoculation. | 3·02 | 0·52 | 2·13 | 1·05 | 0·110 | 0·046 | 243 | 23·28 | 12 | Mainly lacy reticular. but some random flakes present | - |
| 138b | Ground Electrode. (Thro - 14·44 mesh) | Poured two minutes after inoculation | 3·09 | 0·50 | 2·17 | 1·04 | - | - | 219 | 23·36 | 18 | Long random flakes only. | - |
| 142a | ——— | As tapped; poured just prior to inoculation | 2·99 | 0·53 | 2·22 | 1·02 | 0·100 | 0·041 | 239 | 24·40 | 17·5 | Chiefly random, but areas of lacy reticular graphite present | - |
| 142b | Granular Electrode Thro - 28 mesh | Poured two minutes after inoculation | 3·16 | 0·53 | 2·21 | 1·01 | - | - | 215 | 22·46 | 21 | Long random flakes only | - |
| 143a | ——— | As tapped; poured just prior to inoculation | 2·87 | 0·59 | 2·04 | 0·84 | 0·100 | 0·033 | 237 | 24·64 | 15 | Mainly short flake reticular but many random flakes also | - |
| 143b | Lump Electrode | Poured two minutes after inoculation | 2·90 | 0·56 | 2·05 | 0·84 | - | - | 233 | 23·12 | 23 | Medium flakes in random distribution. | - |

Each cupola charge consisted of selected steel scrap and ferro-alloys only.
In each instance, the weight of graphite added = 0·2% of the weight of metal treated.

TABLE VI—*Influence of Ladle Additions of Graphite.*

### Ferro-Silicon Treatment

Experiments were conducted in the addition of ferro-silicon in various proportions to the metal tapped from graphite-free charges, and the results are presented in Table VII. They indicate that from the view-point of efficient inoculation, there is no virtue in excessive ladle additions of this material. Nevertheless, the

## Cupola-Melted High-Duty Irons

greater the proportion of silicon added in the ladle, the more positive is the control over final composition. The disadvantage of heavy additions, however, is the appreciable cooling effect which they exercise on the contents of the ladle, but this may be minimised at no extra cost by the utilisation of rich alloys.

*Influence of Time.*—Transatlantic opinion favours prompt pouring after inoculation on the ground that the effect decreases with the passage of time, and 10 to 20 min. has been quoted as the period of grace. To check the practical significance of this finding an opportunity was taken of melting graphite-free charges, tapping a considerable bulk (25 cwts.) into a hot vessel, and inoculating with an 0.5 per cent. silicon increase in the ladle. Test-bars were cast before, and at time intervals after, inoculation. These were poured from shanks filled at the ladle, and, under control by optical pyrometer, all were cast at the same temperature.

The results, which are those for melt 140, show that inoculation effected the usual change in graphite form and increase in impact value. They also demonstrate that the passage of time did not coincide with reduction in the extent of these improvements, and, since the period studied is greater than that normally elapsing between inoculation and complete disposal, the fears of the writer were allayed.

Other inoculating materials, all relatively expensive, have been tried on a small scale, and such results as the author has available are quoted in Table VIII.

TABLE 7.—THE INFLUENCE OF LADLE ADDITIONS OF FERRO-SILICON.

| MELT No | Grade of the added Ferro-Silicon | Percentage of added Titanium | Percentage of added Silicon | HISTORY OF THE MELT | CHEMICAL COMPOSITION (%) TC | CC | Si | Mn | S | P | PHYSICAL PROPERTIES Hardness (Brin. No) | Tens.-str. (Tons/in²) | Impact (ft. lbs) | MICROSTRUCTURE GRAPHITE | MATRIX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133a | ——— | Nil | Nil | As tapped, poured just prior to inoculation. | 2·76 | 0·50 | 2·48 | 1·10 | 0·081 | 0·055 | 250 | 24·30 | 18 | Mainly in random flakes but a reticular pattern is evident | Pearlitic |
| 133b | 45–50% Silicon (Thro' ¼ mesh) | 0·26 | 0·125 | Poured two minutes after inoculation. | 2·76 | 0·48 | 2·63 | 1·08 | " | " | 248 | 28·73 | 25 | Medium and long flakes in a completely random dispersion | " |
| 131b | " | 0·33 | 0·25 | Inoculating addition made at cupola spout | 2·87 | 0·49 | 2·67 | 1·10 | 0·100 | 0·047 | 250 | 26·40 | 19·5 | Principally in random flakes; reticular pattern traceable | " |
| 126b | " | 0·79 | 0·375 | " | 2·62 | 0·54 | 2·84 | 1·57 | 0·079 | 0·032 | 272 | 29·62 | 20 | Medium flakes in an almost completely random distribution | " |
| 25 | " | 1·05 | 0·50 | " | 2·92 | 0·57 | 2·00 | 1·08 | 0·099 | 0·042 | 241 | 24·08 | 20 | Predominantly random, but a reticular pattern is evident | " |
| 132b | 85% Silicon (Thro' ¼ mesh) | 0·90 | 0·75 | " | 2·63 | 0·69 | 1·99 | 0·66 | 0·080 | 0·048 | 239 | 22·10 | 19 | Principally random, reticular pattern faintly discernible | " |
| 140a | ——— | Nil | Nil | As tapped, poured just prior to inoculation | 2·72 | 0·70 | 1·90 | 1·06 | 0·088 | 0·030 | 248 | 21·80 | 12 | Very fine flakes in a wholly reticular arrangement | " |
| 140b | 85% Silicon (Thro' ¼ mesh) | 0·60 | 0·50 | Poured two minutes after inoculation | 2·66 | 0·65 | 2·25 | 1·07 | " | " | 235 | 21·82 | 20 | Predominantly random, but a reticular pattern is visible | " |
| 140c | " | " | " | Poured seven minutes after inoculation | 2·69 | 0·57 | 2·24 | 1·06 | " | " | 233 | 23·78 | 19 | Long random flakes, entirely | " |
| 140d | " | - | - | Poured twelve minutes after inoculation | 2·67 | 0·52 | 2·20 | 1·05 | " | " | 231 | 22·82 | 21·5 | Long random flakes, entirely | " |

Each cupola charge consisted of selected steel scrap and ferro-alloys only.

TABLE VII.—*Influence of Ladle Additions of Ferro-Silicon.*

TABLE 8:—THE INFLUENCE OF MISCELLANEOUS LADLE ADDITIONS

| MELT No | NATURE OF THE LADLE ADDITION | Percentage of added Titan. | Silicon | Calcium | CHEMICAL COMPOSITION. TC | CC | Si | Mn | S | P | Zn | PHYSICAL PROPERTIES. Hardness (Brin. No) | Tens.-str. (Tons/in²) | Impact (ft. lbs) | MICROSTRUCTURE GRAPHITE. | MATRIX. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % | | | | | | | | | | | |
| 123 | Calcium Silicide (Thro'–¼ mesh) | 0·20 | 0·12 | 0·06 | 2·80 | 0·46 | 3·12 | 1·45 | 0·075 | 0·059 | - | 267 | 25·50 | 16 | Predominantly random; faintly reticular pattern discernible | Pearlitic |
| 117 | As above | 0·40 | 0·24 | 0·12 | 2·86 | 0·38 | 2·67 | 1·23 | 0·052 | 0·041 | - | 253 | 23·54 | 19·5 | Long random flakes, entirely | " |
| 136 | As above | 0·80 | 0·48 | 0·24 | 2·63 | 0·61 | 2·48 | 1·28 | 0·076 | 0·044 | - | 255 | 25·88 | 18·5 | Medium flakes, chiefly random; reticular pattern in evidence | " |
| 134 | Calc.-Ferro-Silicon (Thro'–¼ mesh) | 0·45 | 0·24 | 0·08 | 2·57 | 0·65 | 2·05 | 1·17 | 0·074 | 0·040 | - | 235 | 24·10 | 23 | Medium flakes in almost completely random distribution | " |
| 135 | Sil.-Ferro-Zirconium (Thro'–¼ mesh) | 0·70 | 0·50 | - | 2·74 | 0·68 | 1·59 | 0·85 | 0·100 | 0·036 | 0·05 | 243 | 23·84 | 26 | Medium flakes, in almost completely random dispersion | " |

Each cupola charge consisted of selected steel scrap and ferro-alloys only.
In each instance, the addition was made at the cupola spout.

TABLE VIII.—*Influence of Miscellaneous Ladle Additions.*

## *Cupola-Melted High-Duty Irons*

The writer favours inoculation by ferro-silicon for the following reasons:—(1) The use of a silicon-containing material gives increased control of final composition and reduces the risk of erratic results, and (2) ferro-silicon is as effective as, and more economical than, any of the alternative materials tried. Indeed, its addition in the ladle creates an actual saving since this operation, efficiently performed, incurs less loss of silicon than does cupola melting.

When dealing with normal production taps from charges containing 50 per cent., or more, of returned scrap, the writer's practice is to add ferro-

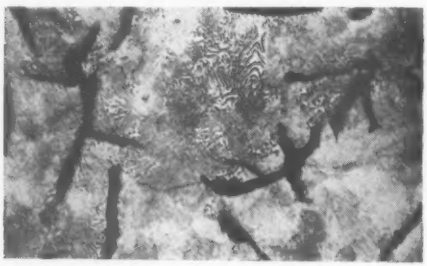

FIG. 13.—TEST-BAR FROM MELT NO. 139*b*. PHYSICAL PROPERTIES: HARDNESS, 210 BRINELL; TENSILE STRENGTH, 20.80 TONS PER SQ. IN.; IMPACT, 18 FT.-LBS. ETCHED (3 PER CENT. NITAL) × 250 DIA.

silicon (45 to 50 per cent. Si), small enough to pass a ¼-in. mesh and in amounts sufficient to add 0.25 per cent. of silicon in the ladle. Where there is particular need for exact control of final composition, the equivalent of 0.5 per cent. silicon is added, use being made of a rich alloy (85 per cent. Si) to reduce the bulk of the addition.

The material should always be dry, and can be heated with advantage. It may be added in the spout or directly to the metal in the ladle. In either case, it should be added in a thin stream, the receiving surface being kept quite bare. If the particles of ferro-silicon come in contact with slag or if the addition be made hurriedly, the efficiency of the operation may be seriously lowered, as was the case with melt 140, where the yield was only 70 per cent. of the possible.

### Recommended Procedure

A diagrammatic illustration of recommended procedure is presented in Fig. 14, which depicts the technique employed and the results obtained on the occasion of a recent melt. It also provides the promised sketch of the cupola, and attempts to portray, in somewhat ideal fashion, the distribution of metals and fuel in the fully-charged furnace.

Full details of the metal charges are quoted in the left-hand table, and the method of controlling composition is shown. The complete charge is regarded as a succession of groups, these corresponding to the individual taps. Each group, in turn, is composed of several unit charges, so arranged that the alloying agents of each group are concentrated centrally. Returned scrap comprises 50 per cent. of the total charge, yet the borders of adjacent groups consist solely of steel scrap and sharp separation of group from group is promoted.

Coke is charged in very light unit, and fairly generous separating, layers. The latter perform a double function. Their presence at strategic intervals ensures regular restoration of bed height and simultaneously assists in the provision of sharp separation between groups. Calculation will show that the ratio of coke to metals charged is approximately 1 to 7. This figure may spell extravagance to conventional judgment, yet the need for really adequate coke allowance with high-steel charges cannot be over-emphasised. The beginner will be well advised to err on the side of generosity, and the proportions quoted will serve as a useful guide to safe procedure.

The ladle additions are detailed and the final analyses and physical test results quoted. It will be observed that the chrome-molybdenum irons are very similar in composition and virtually identical in properties. The unalloyed metal is satisfactory in all respects and the alloy lag has been slight.

### Conclusion

It is the author's hope that this Paper, by inspiring greater interest in the impact resistance of grey irons, will hasten the adoption of standard procedure for the evaluation of this property. Eventual inclusion of impact requirements in the B.S. Specification covering high-duty iron castings would do much to raise the standard of this important product of our industry.

For permission to present this Paper, thanks are due to the directors of Babcock & Wilcox, Limited. The reported investigation was possible only by reason of the fact that excellent resources were at the disposal of the writer. For the enthusiastic co-operation of his colleagues in the Chemical, Metallurgical and Mechanical Test Sections of the B. & W. Research Department, thanks are

(*Continued on page* 123.)

# NEW MT. VERNON ALUMINIUM GRAVITY DIE-CASTING SHOP

*Well-Planned, Rapid and Economical Casting Technique Employed in a New Plant Installed to Meet War Needs of Al Die Castings*

To meet the demand for aluminium die castings for war uses, the Mount Vernon Die Casting Corporation, Mount Vernon, N.Y., has greatly expanded its die-casting plant for rapid and highly economical manufacture, reports HERBERT CHASE in "Iron Age." In all, 15 machines for making aluminium die castings are arranged in rows along two walls, with their metal pots toward the walls and the axis of the machine at right angles to the walls. Between the machines are sheet steel screens to guard against metal spitting, and steel benches on which castings are laid to cool after removal from the dies. Running parallel to the walls near the back ends of the machines are trenches covered with steel plates. In these trenches is all the piping required for hydraulic actuation of dies and goosenecks, low pressure water for die cooling, air for metal injection and gas and oil for heating. There is also a blower line feeding low pressure air to furnaces for combustion. By having all lines under floor level, space overhead is kept clear for light cranes with chain hoists to move the length of the bays above the machines. This, of course, greatly facilitates handling dies into and out of machines as well as handling goosenecks and other heavy parts of the machines that may have to be removed for servicing.

Dies are stored on heavy steel shelves in the basement below the casting floor, and the dies can be dropped through a hatch from the hoist on to a lift truck in the basement. The carrying platform of the truck can be elevated to shelf height so that dies are easily slid on and off shelves and transported by truck and crane into machines without manual lifting. Another unusual feature of the new layout is a belt conveyor that runs below the floor at one side of the pipe trench. Its function is to carry off sprues, gates and any defective castings, thus keeping the floor clear of waste accumulations. This is important because the latter are sometimes as bulky as the castings themselves.

Gates are broken from the castings as rapidly as the castings cool, and the latter are deposited in barrels or tote boxes for transfer to machines for flash removal and such machining as may be required. Gates are broken off castings usually with wooden hammers or by hand, and the gates are then thrown through an opening above the belt which carries them back to a pair of melting furnaces. This avoids transporting bulky loads of gates and sprues in tote boxes, and makes unnecessary dumping and lifting, the gates and sprues into the furnaces. The belt discharges them into a high-level bin with chutes that lead to the two melting pots.

### Alloys and Melting Practice

Nearly all casting is done with Alcoa alloy No. 13, corresponding to A.S.T.M. alloy V, which contains 12 per cent. silicon, the remainder being aluminium. A few castings are made with Alcoa alloy No. 85 (A.S.T.M. alloy VII), which contains 4 per cent. copper and 5 per cent. silicon, the remainder being aluminium. Each casting machine has, of course, its own melting pot, and the aluminium ingots are delivered to it on skids. Machine operators feed in the already alloyed ingots as required to maintain the proper metal level in the pot. With virgin ingots are usually mixed some cast from remelted sprues and gates. The conveyor is used only for sprues and gates of No. 13 alloy. As there are relatively few gates and sprues of No. 85 alloy, they are stored and melted separately.

Each machine melting pot is equipped, of course, with a gooseneck-shaped container having a spout which, just before the casting is made, is lifted and locked against the die. Before this, the gooseneck is submerged in the molten aluminium in the pot and is thereby filled to the required level. Above this level there is only a small air chamber, and when the die is closed and locked and the gooseneck is locked to it, air is admitted under a pressure of 450 lbs. per sq. in. to force the metal into the die. After the die is filled, the air pressure is released and the metal pot is again lowered for refilling.

In the latest Mount Vernon machine, the gooseneck is lifted and lowered automatically by hydraulic means as the dies are being closed and opened, but the toggle locking of the gooseneck is done by a hand lever. An interlock is arranged so that the injection air cannot be applied until the die and gooseneck are properly locked. Dies are opened, closed and locked by toggle mechanisms, but the toggles are operated by hydraulic cylinders actuated from a 350 lbs. per sq. in. water line pressure. Some of the dies used have hydraulically operated ejectors, but both ejector and cores are commonly operated by hand through rack and pinion. Automatically actuated slides are arranged to move some cores positively as dies are opened and closed. This is true especially on machines equipped with "unit" dies.

### "Unit" Dies

These unit dies have long been a feature of Mount Vernon equipment. Basically, they include a frame or holder in which die blocks of a standard size are quickly located and locked. In the case of aluminium casting machines, the frame usually accommodates two separate dies. When a run on one die is completed, another is quickly put in its place. It is possible to change either one or both dies, and either or both dies may have one or more than one cavity, depending upon the size and nature of the casting, core arrangement, and the like. Once in use, however, both dies are filled and operated simultaneously,

## Mount Vernon Al Die-Casting Shop

and the resulting casting gate is ejected with all castings attached from both dies much as if the two dies were in the same rather than in separate pairs of die blocks. The advantage, of course, is a considerable saving in time, both of operator and machine, since a single machine handles two dies almost as rapidly as if a smaller machine with a single die were used.

Where large castings are made or where a single die with several cavities can be used to best advantage, individual rather than unit dies are employed, but machine operation remains about the same. In some cases, where parts are small and are required in large quantities, dies with a dozen or more cavities are most economical and a high production rate is attained. All of the machines, as well as the dies used by this plant, have been designed and built in the plant and embody features found well adapted to the type of worked turned out.

### High-Pressure Machine

The foregoing applies, in particular, to the gooseneck type air injection machine on which most of the aluminium alloy castings are produced. There is, however, one cold-chamber, high-pressure machine of Mount Vernon design in use. Instead of using a gooseneck and air injection, this machine has a positive plunger designed to inject the metal under a 2,200 lbs. per sq. in. line pressure. In this, as in other cold-chamber machines, each charge has to be ladled into the injection cylinder. Before the metal can freeze, the plunger is advanced and forces the charge into the die. The high pressure results in a very dense casting, but casting production is somewhat slower than on gooseneck machines. The high pressure necessitates a large machine with heavy locking pressure and correspondingly limits the size of die that the machine can accommodate. A unit die is employed in this machine, however, and helps to boost its output of castings.

As described, bays along two walls of the new wing are given over to casting machines. A third side is devoted to a room in which gates and sprues are remelted and cast into ingots, and the fourth side adjoins an older portion of the plant into which it opens. The remaining space in the new wing is devoted chiefly to machines for removing flash from castings and performing such light machining operations as are necessary. Most of the machines are for light drilling and tapping, but kick presses for flash removal and belt sanders for smoothing certain faces or for flash removal are also employed. The older section of the plant is equipped with lathes, punch presses, drill presses and other tools, many that are employed for work on zinc alloy, but some of these machines are used on aluminium when necessary. It is aimed, however, to keep as much of the aluminium work as possible in the new wing, and most of it will be done there as new equipment is received and installed.

In this, as in most die casting shops, the jobs are constantly changing, and equipment has to be adapted as well as possible to the particular jobs going through at any given time. Where unusually long runs can be made, as for certain war jobs, specialised tooling and tool arrangements are set up to put it through in a most efficient manner. When runs are short, only the simplest tooling is usually justified, and some flash removal is even done by filing, though such work is minimised.

### Casting Booster Cups

Typical of small parts produced in large quantities are booster cups which, in shape, resemble a pipe cap. They measure about 1¼ in. o.d. and are about 1 in. deep. They are produced 14 on a single gate, and the casting machine makes about 90 shots an hr., thus yielding 1,260 castings an hr. The interior of each casting is cored out, and the gate is forced off the 14 core pins by a hydraulically operated ejector which saves much time and manual effort. Control of the ejector is through a valve moved by hand. Gates containing the 14 castings are laid on a bench to cool, and are slid along to an inspector who breaks off the castings, deposits them in a barrel and throws the gate on to the belt conveyor which carries them back to be remelted.

Next to the inspector is a bench with a pair of drill presses, each equipped with a counter bore and a quick-operating holding fixture. The operator at each press feeds the cups, one at a time, into the fixture and lowers the counter bore which faces the open end, and at the same time cuts off the flash. The operator then passes the cups to another pair of larger drill presses equipped with collapsible taps which form a thread about half way down the inside diameter. Oil is supplied to the taps by a pump from a central tank after the cups are clamped, one at a time, in the lever-operated fixture. Next, the cups are placed in a punch press, being held in a fixture as the punch is lowered. The punch expands the cup very slightly, straightening the bore which has a slight draft, so that the thread gauge, subsequently applied, will clear.

Finally, the cups are placed on a mandrel in a light lathe and the lip is touched with a file to remove any fine burr so that the cup will pass through a gauge hole. The operations are done at a rate sufficient to keep pace with the casting machine, using multiple machines when necessary. Tapping is the slowest operation and has been done at the rate of 350 pieces per hr., but a new type of tapping machine now being installed will do 600 per hr.

### Tubular Castings

In contrast with this is the production of a tubular casting about 8 in. long and 2 in. in dia., having a 3-in. flange at one end, this being one of the parts for an airport beacon. As this is a fairly large casting and requires that a long core be pulled, it is cast in a single-cavity die at the rate of 60 an hr., two men being required on the casting machine. One operates the machine and the ejector lever and the other

## *Mount Vernon Al Die-Casting Shop*

operates the core through a rack and pinion mechanism, using a long lever on the pinion shaft to break the core free. A third man breaks off the gates and loads castings into a tote box for transfer to a bench equipped with four drill presses and suitable jigs for holding the piece while it is machined. The operations required include the removal of flash by drilling from 12 holes cores through the flange, drilling one cross hole, countersinking the flange holes and facing one end.

Another machine is equipped with a unit die holder in which are two dies each having two cavities. The machine used for making castings at 2,200 lbs. per sq. in. line pressure is also equipped with a pair of unit dies. A charge of aluminium alloy is dipped from a metal pot separate from the machine, and, as soon as it is in the cold chamber, the operator throws a lever that admits oil at a pressure of 2,200 lbs. per sq. in. to the ram cylinder, advancing the ram and forcing the charge into the die. The metal is kept close to its melting point and, when injected, is really in a semi-molten condition. In all cases, to insure complete filling in of the die, the charge ladled in is somewhat greater than sufficient to fill the die cavities and gate passages. Also filled is a slug space at the ram end, this space holding the excess charge.

When the castings solidify, the dies are opened and the ram forces the slug out of the recess in which it is formed, and it is ejected as a part of and along with the gate of castings. The ram has a diameter of 2 in., but is advanced by a piston of larger diameter. This larger diameter of the piston, of course, multiplies the pressure applied to the metal in contact with the ram. Dies are toggle operated by a ram on a 350-lb. line as in the other machines described. Production in this machine, used chiefly for casting instrument parts, runs about 75 shots per hr., but, as there are two dies and each may have more than one cavity, several castings are often produced in each shot. Castings, still on the gate, are placed in tote boxes or barrels, transferred to an inspection bench where they are broken from the gate, and defective castings are rejected. The machining operations that follow remove flash and cut away such excess metal as may be required on the particular castings involved.

The new plant is well arranged for rapid production. This applies not only to the casting operations, but to subsequent machining as well as to the handling of metal, gates and sprues and to moving dies into and out of machines.

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**Enamel for Hot-Water Service.**—Various methods for determining the corrosion resistance of enamel for hot-water service were discussed by W. W. Higgins at the recent convention of the American Ceramic Society.

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## SAVE WASTE PAPER FOR MUNITIONS

## WEATHER RESISTANCE OF VITREOUS ENAMELS

A study of the weathering resistance of vitreous-enamelled architectural panels was begun by the National Bureau of Standards in 1939, which involved 864 panels, 1 ft. square, representing 14 types of enamel and a like number of 4-in. by 6-in. laboratory specimens, reported W. N. Harrison and D. G. Moore, of the Bureau, at the recent convention of the American Ceramic Society. At the end of the first year of exposure at four locations, which were selected for climatic conditions, more than one half the panels showed no visible effect and in no case did weathering produce any failure of the enamel to protect the underlying metal from rusting. Full matt enamels were unsuited for architectural use where appearance is important because of fading and of difficulty in cleaning. Mild fading, found on some of the non-acid-resistant coloured enamels, was associated with a minute pitting of the enamel surface, probably caused by the presence of acid-forming gases in the atmosphere. Enamels of high-acid resistance did not show this effect. Weathering was more pronounced at those locations where there is a relatively high concentration of combustion gases, and it was less severe where there is a practical absence of these gases in the atmosphere. An accelerated weathering test is described, which gives an effect closely resembling the most important form of actual weathering.

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## CUPOLA-MELTED HIGH-DUTY CAST IRONS

(*Concluded from page* 120.)

tendered to Mr. W. G. Marskell, Superintendent. Individual acknowledgment, however, must be made of the assistance rendered by Mr. J. S. Vipond, also of the Research Department, who has acted throughout as guide, photographer, and friend, and whose professional skill has so adorned this Paper. Finally, and once again, to Mr. Robert O. Patterson, Foundries' Superintendent, for his constant support, helpful advice and inspiring encouragement, the warm thanks of the author are publicly expressed.

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# FUEL EFFECTS ON CONTROLLED ATMOSPHERES

## INFLUENCE ON CARBURISATION

The effects of gaseous, liquid, and solid fuels, as well as other factors, on the amount and rate of carburisation and decarburisation of steel in controlled-atmosphere and regular heating furnaces, are described by F. A. LOCKE in "The Iron Age." The two chief gaseous fuels, natural gas and coke-oven gas, he states, contain relatively large amounts of hydrogen. Natural gas is approximately two-thirds hydrogen by volume. Combustion of these two gases will tend to produce decarburising atmospheres for two reasons: (1) Combustion of the large amount of hydrogen will produce large amounts of water vapour and possibly some moist hydrogen, and (2) these fuels, being easily atomised, will produce mainly products of complete combustion, that is, water vapour and carbon dioxide.

The other gaseous fuels, anthracite and bituminous producer gas, will atomise easily and produce mainly products of complete combustion. However, since the hydrogen content of these two gases is comparatively low, only a small amount of water vapour will be produced, and thus the atmospheres produced by the combustion of these two fuels will be less decarburising than those produced by the former two fuels.

### Liquid and Solid Fuels

Fuel oil is the main item to be considered in the liquid-fuel class. Although fuel oil in general atomised easily, it does not atomise as easily as gas, and the atmosphere produced by the combustion of oil might possibly contain some unburned fuel in the form of carbon-monoxide gas and particles of carbon, along with the products of complete combustion. The hydrogen content of oil is lower than the hydrogen content of water vapour. Therefore, only a moderate volume of water vapour will be produced. In general, the atmosphere produced by the combustion of oil will be less decarburising than the atmospheres produced by the combustion of the gaseous fuels, particularly those having a high hydrogen content.

Bituminous coal and coke are the two main fuels in the solid-fuel class. Solid fuels are the most difficult to atomise and the atmospheres produced by their combustion will most likely contain unburned fuel. Bituminous coal contains very little and coke contains virtually no hydrogen. Thus, combustion of either of these fuels produces little, if any, water vapour. Atmospheres produced by combustion of the solid fuels will be the least decarburising of the three types, and might easily be carburising because of the presence of carbon-monoxide gas and particles of carbon.

### Other Determining Factors

Several other factors that influence the amount and rate of decarburisation or carburisation in addition to the composition and combustion of the various fuels are as follows: (1) Composition of the material undergoing treatment; (2) the temperature of the treatment; (3) the length of time at that temperature; (4) condition of the surface of the steel undergoing treatment, and (5) the oxidising (scaling) power of the atmosphere surrounding the steel.

The first three of these factors can be explained as follows: Increases of temperature, and increases of time at temperature will raise the amount and rate of decarburisation or carburisation. The ease of carburisation varies inversely as the original carbon content of the material and/or the ease of decarburisation varies directly as the original carbon content of the material for any given time and temperature.

The other two factors will be considered together as they are closely related. Recent investigations have established several facts concerning the surface of the steel undergoing treatment and the oxidising power of the atmosphere surrounding the steel: (1) A coating of scale on any steel at elevated temperatures retards the rate of either decarburisation or carburisation, and minimises the ultimate amount of surface carbon change. (2) Since an oxidising atmosphere produces scale, it is advisable to take advantage of this reaction whenever possible in adjusting furnace atmospheres. (3) Furnace atmospheres containing from 1 to 4 per cent. excess oxygen have been found to produce the best rate and amount of scaling for protection against decarburisation or carburisation. It has also been found that for temperatures much above 1,500 deg. F. the rate of decarburisation in oxidising atmospheres becomes dangerously great. Some observers have found that excessively oxidising atmospheres will produce carburisation of high carbon steels (over 0.70 per cent. carbon), if only heated for short periods of time. This has been explained by the fact that the oxygen selectively attacks the iron of the steel, while the carbides migrate back into the unoxidised steel, forming a ring of excess carbides at the interface of scale and steel. However, if the steel is held at temperature much more than an hour under these conditions, the reaction quickly reverts to decarburisation.

### Practical Criteria

In applying this information about scale and atmosphere oxidising power to the effects produced by various fuels on steel surfaces, the following points must be considered: (1) Fuels that atomise easily and thus produce products of complete combustion have a tendency to produce decarburising atmospheres due to the presence of only the products of complete combustion ($CO_2$ and $H_2O$), which are both decarburising, and (2) fuels that are not easily atomised produce some unburned fuel which is carburising to the steel.

However, an atmosphere composed entirely of carbon dioxide and water vapour, along with nitrogen, has greater oxidising power than an atmosphere containing some unburned fuel. Thus, the oxidising power, with the ultimate formation of scale, produced by such an atmosphere will to some extent counteract the decarburising effect of carbon dioxide and water vapour.

# REPORT ON REFRACTORY MATERIALS

The Second Report on Refractory Materials, forming Special Report No. 28, issued by the Iron and Steel Institute, comprises four sections: (*a*) Foreword by Dr. T. Swinden and Mr. A. T. Green, with a list of Committees and Panels; (*b*) steelworks refractories consisting of a description of the work of the Open Hearth Refractories Joint Panel, a study of the reactions between dolomite and various minerals, and a note on a simple partially-stabilised dolomite mixture; (*c*) blast-furnace refractories made up of a Paper on "The Influence of Working Conditions in the Durability of Blast-Furnace Linings" and "Temperature Gradients through Blast-Furnace Linings," and (*d*) a summary of other published work of the British Refractories Research Association of interest to the iron and steel industry.

In the course of the foreword, it is stated that since the issue of the First Report on Refractory Materials by the Joint Refractories Research Committee of the Iron and Steel Industrial Research Council and the British Refractories Research Association in March, 1939 (Special Report No. 24), a very considerable amount of work has been carried out on the various types of refractory used in the iron and steel industry and published in the confidential bulletins of the B.R.R.A. It has, therefore, appeared desirable to reprint certain of these Papers as a Second Report. It was further decided to include a summary of other recent investigations in this report.

For some time prior to the outbreak of war, the Open-Hearth Refractories Joint Panel had devoted its attention chiefly to basic refractories. The interest was such that when hostilities began, the B.R.R.A. rearranged a part of its programme with a view to preparing a bulletin devoted to this subject. This bulletin, published in September, 1940, contained a comprehensive review on basic refractory materials, and eleven Papers describing the results of original research. In view of the difficulty in obtaining supplies of magnesite in wartime, it was inevitable that a major proportion of these research Papers should deal with alternative types of basic refractory, particularly stabilised dolomite. This work has continued during 1941, and it is felt that, as a result, a better appreciation of the constitution and behaviour of basic refractories has been attained. Certain of the Papers on stabilised dolomite are reprinted in the present Report.

Supplementary to this research has been the preparation of a report on "Methods of Testing Basic Refractory Raw Materials and Products"; this was published in July, 1940, and was circulated within the steel industry by the British Iron and Steel Federation. It was felt, however, that the tests described should be used as a preliminary to service tests; the Open-Hearth Panel therefore drew up a standard service test-sheet for basic refractories used in the open-hearth furnace, and this was published in March, 1941. The Panel has also sponsored observational

(*Continued in next column.*)

# LENGTH OF THE WORKING WEEK

## INDUSTRIAL MINIMUM OF 52 HOURS

Standardisation of a minimum 52-hr. week for industrial work and one of 46 hrs. for clerical work, with a maximum fortnight's holiday in the year, from now till the end of the war, is the aim of new measures which are being taken by the Government. Hours of work in excess of those fixed by industrial agreements will be regarded as overtime. The new standard week is to apply to women and juveniles, which means that, wherever introduced, the Factory Act limitation of their hours will have to be waived.

Account will be taken of these standard hours when assessing the labour force required by any industry or undertaking. Where the hours of industrial workers fall short of 52 and those of office staffs fall short of 46 it will be assumed that a reduction of staff could be achieved by increasing the hours of work of the staff retained unless there are special circumstances which make this inappropriate. Where a large proportion of married women is employed, it might not be reasonable to ask them to work 52 hours. Similarly, in small businesses where only a few persons are employed on any one kind of job, it might be necessary to retain a man on his specialised work, although it did not occupy 52 hours.

### Freeing Workers

Hours are not to be increased merely to comply with the new requirements. The purpose of the increase is to set workers free for other occupations or for the services. There will be an application of the 52-hr. week to individuals as well as to undertakings and industries. Workers in places where the general hours are not raised, but who could reasonably be expected to work longer, will, so far as practicable, either be withdrawn and replaced by suitable workers who are available only for the shorter hours, or else they may be expected to give additional services as part-time workers in other work.

The Ministry of Labour states that, although many industrial undertakings are working long hours, many others, as well as many non-industrial establishments, have not increased their hours much, if at all, beyond the peacetime level.

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## REPORT ON REFRACTORY MATERIALS

(*Continued from previous column.*)

work on the conditions in an open-hearth furnace as they affect the life of the roof.

The Blast Furnace Refractories Panel has made a detailed examination of the temperature gradients in the lining of a blast furnace throughout a campaign, and has also been carrying out work on the production of carbon blocks. War conditions, it is stated, have stimulated research activity in the refractories industry; this is exemplified by the recent formation of two sub-committees of the Open Hearth Refractories Panel which deal respectively with Basic Bricks and Casting-Pit Refractories.

## NEWS IN BRIEF

MR. JOHN WINNING, organiser and secretary of the United Patternmakers' Association for the Clyde area, has resigned for health reasons.

OVER 3,000 WOMEN who have undergone training in the Glasgow Royal Technical College and the Stow College have been placed in engineering establishments.

AMERICAN PRODUCTION of commercial steel castings last year totalled 1,316,027 tons, the largest since 1929 and almost double the 1940 figure, states the U.S. Department of Commerce.

HALE & HALE, LIMITED, malleable ironfounders, of Tipton, have acquired the business of Chatwins, Limited, stove and grate manufacturers, also of Tipton. Chatwins, Limited, was established in 1862.

LORD ILLINGWORTH, chairman of the United States Metallic Packing Company, Limited, and a director of the Ford Motor Company, Limited, and other companies, a former Postmaster-General, left £297,329.

A LETTER RECEIVED from Mr. J. E. Oram, of Wild-Barfield Electric Furnaces, Limited, Watford, calls attention to the extreme usefulness of the Spekker Steeloscope for the detection of tungsten in mixed scrap.

A FURTHER SERIES of regulations designed to reduce the country's consumption of tin is issued as the Control of Tins, Cans, Kegs, Drums and Packaging Pails (No. 7) Order, 1942. The cutting up of tinplate is prohibited for an additional range of packages and closures for civilian use.

T.I. (GROUP SERVICES), LIMITED, has been formed as a private company with a capital of £1,000 to provide any services required by Tube Investments, Limited, or any subsidiary company. Its powers include those of buyers, sellers or buying and selling agents for the companies.

ASKED if he was satisfied with the output of the machine-tool industry, Mr. Oliver Lyttelton, Minister of Production, said he would not be satisfied until there was no point at which we were waiting for a machine tool, but the current rate of production was more than six times the normal output.

IN 1940, PERU produced 1,254 metric tons of vanadium (metal content), against 1,016 tons in 1934, representing over 35 per cent. of world production; bismuth output was 382 tons, against 215 tons, or about 30 per cent. of world output. Copper production was 37,686 tons in 1940, zinc 17,000 tons, and lead 46,253 tons.

REPRESENTATIONS having been made to the Minister of War Transport by a Lincolnshire M.P. regarding delays in steel transport, a transport committee has been set up with Mr. W. J. Brooke, managing director of the Normanby Park Steelworks of John Lysaght, Limited, as chairman. Mr. E. Pittwood, a Scunthorpe firm's transport manager, is secretary.

AN INDUSTRIAL TRUCK MANUFACTURERS' ASSOCIATION has recently been formed, consisting of concerns who are manufacturers of power-operated industrial works trucks, tractors or trailers and ancillary equipment, which are primarily for internal works use. The affairs of the Association will be conducted through the secretaries—Peat, Marwick, Mitchell & Company, York Mansions, 94/98, Petty France, Westminster, S.W.1.

PROPOSALS FOR stimulating war production made in the report of the Committee on Regional Boards have been accepted by the Government. Sir Walter Citrine is chairman of the Committee, which was appointed by the Minister of Production in February to examine the constitution and functions of the Production Executive's Regional Boards and of the Central Joint Advisory Committee to the Production Executive, and to make recommendations as to any changes that might appear to be necessary or desirable.

RESEARCH activities during 1941 had again covered a wide field, said Lord McGowan at the annual meeting of Imperial Chemical Industries, Limited. They had embraced problems arising out of new plant conditions brought about by war circumstances, such as the substitution of novel raw materials for normal ones now unprocurable, and the development of entirely new products of both present national and possible future commercial importance. They transferred to our Allies, without hesitation, any technique which would serve their interest in the common war effort.

## PERSONAL

MR. JOHN A. MILNE has been re-elected president of the British Colour Council, and Mr. C. M. Whittaker chairman of the Board of Management.

VISCOUNT RIDLEY, who has been appointed Director of Producer-Gas Vehicles by the Minister of War Transport, is a director of the Consett Iron Company, Limited.

MR. O. W. ELLIS, of the Research Foundation, Ontario, has been awarded the Duggan medal and prize of the Engineering Institute of Canada, for a Paper on "The Forgeability of Metals."

PROF. C. L. FORTESCUE, Professor of Electrical Engineering, City and Guilds College, South Kensington, has been nominated by the council for the presidency of the Institution of Electrical Engineers.

### Wills

| | |
|---|---|
| BUSH, H. J., of the Aluminium Castings Company, Limited, Greenock ... ... ... ... ... ... | £12,309 |
| PENN, JOSEPH, of Stourbridge, Worcestershire, retired ironmaster ... ... ... ... ... ... | £87,279 |

## WORKERS' CLOTHING COUPONS

In connection with the fourth award of additional clothing coupons to industrial workers the Board of Trade has added the following to the list of awards to workers in miscellaneous occupations in the metal trades: Welder, electric arc (not spot, seam or butt) and acetylene, 25 coupons. Metal spinner, 10 coupons. Applications by employers on behalf of these workers should be made to local Labour Offices by May 31.

# STANTON

*Dale*

**REFINED**

# PIG IRON

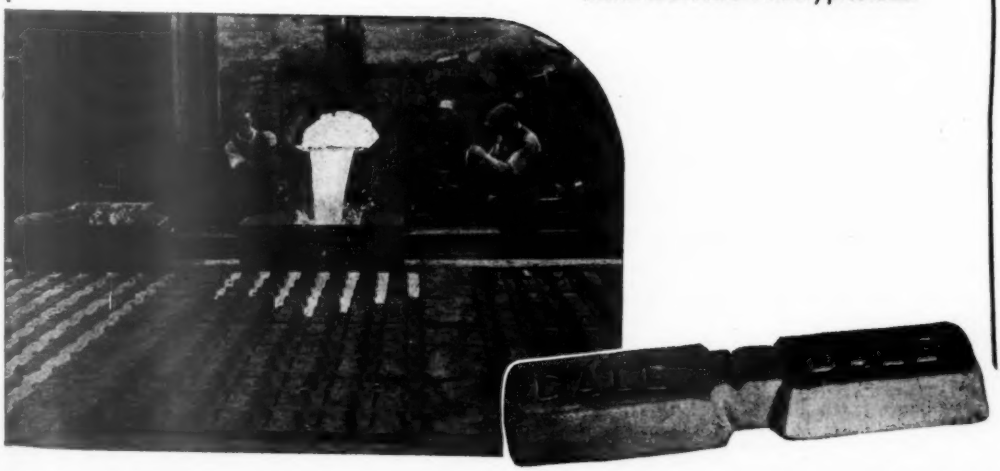
**IS CHARACTERISED** by closeness of grain structure, uniformity of composition and fine graphitic carbon evenly distributed.

**IS PRODUCED** to guaranteed analysis in seven standard grades.

**CAN BE MADE** to customers' individual requirements with total carbon from 2·6 per cent. upwards.

**SHOULD BE USED** to tone up high phosphorus irons and scrap, to replace Hematite, and to produce castings for all high duty purposes.

*Users are invited to avail themselves of the Stanton Technical Service which offers free expert advice on special mixtures and other Foundry problems.*




**THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM**

## COMPANY NEWS

*(Figures for previous year in brackets.)*

**Cochran & Company, Annan**—Interim dividend of 1¼%, tax free (same).

**Marshall, Sons & Company (Successors)**—Interim dividend of 3¼% (same).

**Brooks & Doxey**—Net profit for year to March 31, £3,734 (£2,370); debit forward, £197,018 (£200,752).

**Metal Agencies**—Profit for the year to February 28 last, £51,690 (£46,914); dividend on the ordinary shares of 20% (15%).

**Kitchen & Wade**—Profit to March 31, 1941, £107,106 (£120,860); tax, £78,642 (£64,750); to reserve, £5,000 (£15,000); dividends totalling 30% (45%); forward, £1,522 (£1,963).

**Anderson-Grice Company**—Gross profit for year to September 30, 1941, £23,807; brought in, £2,048; depreciation, £2,640; taxation, £16,100; ordinary dividend of 3s. 6d. per share; forward, £845.

**Projectile & Engineering**—Profit for 1941, after taxation, £104,539; to general reserve, £10,000; to obsolescence reserve, £30,705; maintenance reserve, £5,556; final dividend of 7½% on the ordinary shares, together with a bonus of 5%, making 20% (same); forward, £33,635 (£35,357).

**Richard Johnson & Nephew**—Profit for the year ended March 31, after depreciation, tax, and E.P.T., £41,606 (£47,895); staff and workmen's pensions, £7,500; to general reserve, £10,000; 7% preference dividend, £10,500; ordinary dividend of 9% (same), £13,500; forward, £38,892 (£38,786).

**Babcock & Wilcox**—Trading profit for 1941, £702,601 (£789,338); income from investments, etc., £75,189 (£95,691); net profit before tax, £616,021 (£717,347); taxation, £365,000 (£451,058); dividend and bonus on the ordinary capital of 11% (same), £242,930; preference dividends, £7,664; forward, £105,709 (£105,282).

**John Summers & Sons**—Net profit for 1941, after providing for depreciation and taxation, £352,892 (£294,856); war damage insurance, £55,588; to reserve, including £40,000 covering debenture stock redeemed in December, 1941, £140,000; dividends on the "A" ordinary stock of 6% and "B" stock 2%, £140,000; forward, £173,581 (£156,277).

## IN PARLIAMENT

**Scrap Merchants' Commission**

MAJOR LYONS asked the Minister of Supply, in view of the duties and scope of the Director of Scrap Supplies, why there was still paid to each of four firms of scrap merchants an over-riding commission of 1s. per ton of scrap.

SIR ANDREW DUNCAN: The arrangement was one entered into between the steel industry and four scrap merchanting firms. Neither the Ministry nor the Iron and Steel Control is a party to this arrangement. I have asked the steel industry to look into the agreement again in the light of the circumstances of to-day and to report to me fully upon it.

## OBITUARY

MR. CLEMENT LE HARIVAL PERROT, steel merchants' representative, of Sheffield, died recently.

MR. JAMES THOMSON, late of W. & J. Forrester & Company, Limited, Larbert Brassworks, Stirlingshire, has died at Whitehaven at the age of 79.

MR. THOMAS RENNIS SCOTT, who died at Edinburgh on May 21, was a director of Miller & Company, Limited, London Road Foundry, Edinburgh. He had been with the firm for many years.

MR. HARRY FRED LEE ORCUTT died on May 17. A native of Elsworth, Maine, U.S.A., he came to England to join Clayton & Shuttleworth at Lincoln in 1904, and he was appointed general manager of the Birmingham Small Arms Company in 1909. Soon after he became interested in earlier developments of gear tooth grinding, and studied the process both in the United States and Germany. After several years of development work he evolved the system and process now known by his name. In 1939 the Gear Grinding Company, Limited, of which Mr. Orcutt was founder and chairman, moved to new works near Birmingham, now managed by his two sons. He was 81 years of age.

DR. G. G. STONEY, F.R.S., who had done much work on the development of the steam turbine, died on May 15. He was 78. Educated at Trinity College, Dublin, where he earned distinction in experimental science, he afterwards gained experience with the Dublin Port and Docks Board. For nearly a quarter of a century from 1888 he was connected with the Parsons Company at Newcastle, and to them he returned as director of research during the years 1926-30, having in the interim been Professor of Mechanical Engineering in the College of Technology and in Victoria University, Manchester. For many years he was prominently identified with the North-East Coast Institution of Engineers and Shipbuilders and was a member of the Council of King's College of Durham University.

## CONTROL OF COBALT

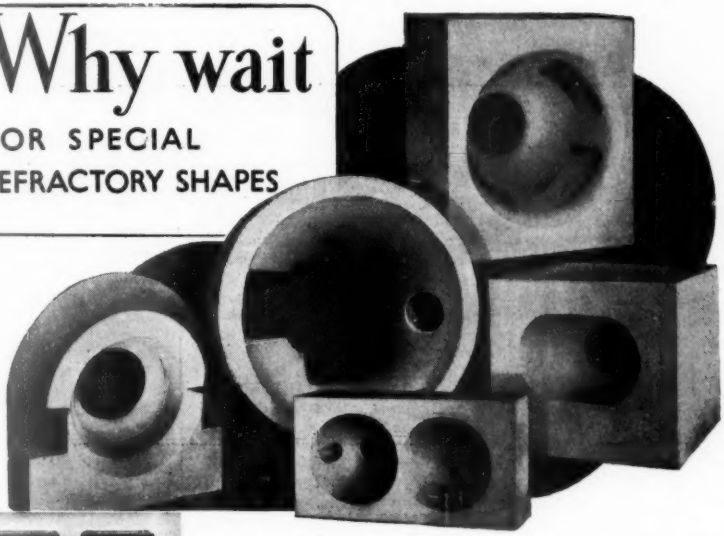
In future, licences will be required by importers or manufacturers to dispose of cobalt and certain specified materials containing cobalt imported into or produced in the United Kingdom. The material cannot be acquired from the importer or manufacturer unless he has a licence or unless the acquirer is authorised by licence.

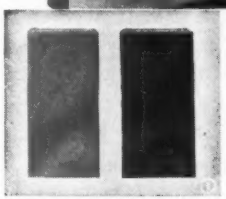
This is the effect of an order issued by the Ministry of Supply, the Control of Non-Ferrous Metals (No. 10) (Cobalt) Order, 1942. The specified materials are:—Cobalt-bearing ores, concentrates and mattes, residues from which cobalt can be recovered, cobalt metal, cobalt oxides, and the following salts of cobalt: acetate, ammonium sulphate, carbonate chloride, hydrate, nitrate, phosphate, sulphate.

Inquiries concerning the Order should be addressed to the Joint Controllers of Non-Ferrous Metals, Grand Hotel, Rugby.

# Why wait

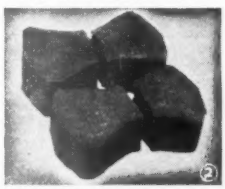
FOR SPECIAL
REFRACTORY SHAPES





**NO SHRINKAGE.** Illustration (1) shows two blocks cast in moulds and dried at atmospheric temperature. One was fired to 1500° C for four hours. Specimens are the same size.

**STRENGTH.** Illustration (2) shows two test pieces cast in moulds, dried at atmospheric temperature and one heated to 1000° C. Tensile strength —*Unfired*, 550 lbs. per sq. in. *Fired*, 1312 lbs. per sq. in.



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## Make them quickly and economically

## *with* DURAX No. 2

## REFRACTORY CONCRETE

IN CASES of emergency, special shapes and replacements may be made quickly with Durax No. 2 Refractory Concrete. Mixed similarly to ordinary building concrete, Durax is poured into position, dries quickly and sets to a remarkable degree of hardness. There is no permanent volume change and tests have shown no signs of fusion below 1580° C—there is no tendency to crack or spall. Durax No. 2 is used for protection of header tubes and drums in water tube boilers, access door and lid linings, flame baffles, burner blocks, furnace and coke oven door linings, complete monolithic linings, small monolithic arches and all types of special shapes.

## General Refractories
LIMITED

GENEFAX HOUSE SHEFFIELD, 10, ENGLAND.
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G.P.33

## *Raw Material Markets*

### IRON AND STEEL

Concentration in the ironfoundry industry will affect mainly the light-castings section of the trade, as activity in other departments is devoted largely to Government business or orders otherwise connected with the war effort. For a long time past the majority of firms engaged on the manufacture of light castings have been operating on a short-time basis. At the outbreak of the war a start was made in conserving materials for the war machine and this resulted in much of the export trade and home business in light castings being banned, while hoped-for contracts from the Government did not materialise on anything like the scale which had been expected. Certain firms were able to adapt their resources to the needs of the Government, but, as far as the others are concerned, conditions have been distinctly quiet.

The experience of the heavy engineers has been very different, demand for the bigger castings having been consistently strong. Plant extensions and developments have had to be carried out in order to cope with the pressing requirements of Government departments and it has not been easy to obtain the necessary raw materials for the production of these castings. Owing to the need for conserving shipping space imports of the foreign ores utilised in the manufacture of the better quality irons used by the heavy foundries have been curtailed, while the exigencies of war have contributed other difficulties also which have not been easily surmounted. But by the use of high-phosphorus iron, refined iron and scrap, etc., it has been possible for the industry to record excellent outputs. Hematite continues to be particularly scarce, while supplies of low-phosphorus iron are also difficult to come by and are reserved by the Control authorities for use when alternative grades are not to be found.

The Whitsuntide holiday in the steel industry, where taken at all, was of very short duration, usually no longer than was necessary to carry out renovations to plant. So insistent is the call for supplies that no works can afford to cease production, nearly all orders being for urgent Government specifications. This is especially applicable to the works producing special alloy qualities of steel, which are so vital to the output of munitions, armaments, aircraft, etc. Many other branches are busily employed, also; for example, steel-plate makers are required to supply shipbuilders, wagon and tank makers, etc., with big quantities of steel, while black sheets are keeping the sheet makers busily employed despite the ban on the manufacture of galvanised sheets for other than Government orders.

Scrap iron and steel buyers are keen to acquire additional tonnages for stocking against their future needs, but little progress has so far been made in this direction as regards the better and heavier qualities, as immediate consumption accounts for nearly all the material available. Very little scrap is now being imported, so that home sources of scrap have to be relied upon for supplies. Light scrap is plentiful.

### NON-FERROUS METALS

It would seem as if the tin production at the disposal of the Allies has developed rather more favourably than expected. In Bolivia it is hoped that the 1929 record shipments may be at least repeated this year. The American authorities are giving priority to equipment required by the Bolivian tin-mining industry, while technical advice is also forthcoming. The main hindrance to the expansion programme is the labour shortage. Bolivia is the largest source of production outside the Pacific zone. In the Belgian Congo the newly formed War Minerals Board has taken over control of tin developments. Mining has been expedited in Katanga, in the Great Lakes area and in Ruanda-Urundi. Mining equipment has been promised by the United States, and it is hoped that skilled engineers will be placed at the disposal of the Congo as a result of Allied discussions. Prospects in Nigeria are still somewhat confused; it was earlier reported that the Ministry of Supply had asked Nigerian producers to increase their output of tin with the aid of Malayan experts, but this has been denied. More reliable reports, however, indicate that Nigerian output will be raised considerably this year, plant and equipment being supplied under priorities. Australian and South African output of tin is expected to be increased this year, but all the metal produced will be used internally, as also will the several hundred tons which may be raised in Canada during the current year.

Mr. William L. Batt, chairman of the American War Production Board, announced recently that further heavy cuts are to be made in civilian consumption of copper in the U.S.A. The expansion in the production of war materials has been so extensive that something of a shortage of the red metal has resulted. New restrictions are likely to save about 60 per cent. of the tonnage of copper consumed by civilian users in 1940. Mr. Beasley, the Australian Minister of Supply and Development, has announced that the selling price for refined copper in the Commonwealth is to be increased from £A.86 10s. to £A.105 per ton. The basic price to producers for their normal output will be £A.100 per ton, with a bonus of £A.5 per ton for output in excess of normal. Mr. Beasley expressed the hope that the increased prices and the efforts of the Government to stimulate the development of low-grade ores would result in substantially increased production of copper in Australia.

Supplies of spelter and lead are being delivered to war factories without delay, but economy is being practised in the usage of both metals, and non-war consumption has been appreciably lowered.

---

PAYING TRIBUTE to the company's workers, Sir John Greenly, chairman of Babcock & Wilcox, Limited, said that the persistent cry that men were not working, and that managements were not striving for the fullest possible production, was untrue. It was time that a protest was entered against irresponsible and ill-informed criticism, which constituted a grave injustice.

# Why?

*Why do we advise the installation of Riley Industrial Robot Stokers? Because :—*

When applied to metallurgical furnaces, the close control of temperature ensures the heating of the furnace in the shortest possible time. The steady furnace temperature leads to a greater output with more uniform soaking of the billet or ingot.

Combustion conditions can be varied to suit the requirements of the metallurgist.

Riley Industrial Robot Stokers comply with the anti-glare regulations.

When applied to core drying ovens the automatic stoker control ensures maintenance of the required oven temperature and results in more efficient drying of the cores.

**RILEY STOKER**
**CO. LTD.**
**NINETEEN WOBURN PLACE**
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'Phone : HIGH WYCOMBE 1792 (3 lines).
PUBLISHED WEEKLY : 21s. per annum (Home and Overseas).

OFFICIAL ORGAN OF : The Council of Ironfoundry Associations The Institute of British Foundrymen ; The Institute of Vitreous Enamellers ; The Welsh Engineers' and Founders' Association ; The Foundry Trades' Equipment and Supplies Association.


## COUNCIL OF IRONFOUNDRY ASSOCIATIONS

Chairman : FitzHerbert Wright, The Butterley Company, Ripley, near Derby. Secretary : V. Delport, 2, Caxton Street, Westminster, S.W.1.

*Participating Associations* : National Ironfounding Employers' Federation ; British Ironfounders' Association ; National Association of Malleable Ironfounders ; Ironfounders' National Confederation ; British Bath Manufacturers' Association ; British Malleable Tube Fittings Association ; Cast Iron Chair Association ; Greensand Pipe Founders Association of Scotland ; Cast Iron Heating, Boiler, and Radiator Manufacturers' Association ; Cast Iron Segment Association ; National Ingot Mould Association ; Cast Iron Axlebox Association ; Institute of British Foundrymen (affiliated) ; British Cast Iron Research Association (affiliated) ; British Grit Association (affiliated) ; Agricultural Engineers' Association (affiliated).

## INSTITUTE OF BRITISH FOUNDRYMEN

PRESIDENT, 1941-42 : Major R. Miles, M.Eng. Head Wrightson & Company, Limited, Thornaby-on-Tees.

LIST OF SECRETARIES—

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